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Electrocatalytic oxidation of $K_4[Fe(CN)_6]$ by metal-reducing bacterium *Shewanella oneidensis* MR-1

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The microbial metabolic activities between minerals and bacteria play a role on biogeochemical cycling of metal compounds[1]. One of these activities is extracellular electron transfer (EET), in which some microbes exchange electrons with external redox minerals, electrodes or even other microorganisms[2, 3].
In this study, we observed that *Shewanella oneidensis* MR-1 (MR-1) selectively catalyzed the electrooxidation of $K_4[Fe(CN)_6]$ to $K_3[Fe(CN)_6]$. A surprising asymmetric pair of voltammetric peaks is found in cyclic voltammetry (CV) of $K_4[Fe(CN)_6]$ on a MR-1 coated glassy carbon electrode (GCE). The oxidation catalysis is obvious under slow scan rate and low $K_4[Fe(CN)_6]$ concentration. The uniqueness is validated by the exclusion of other microbes and other redox compounds. Extracellular polymer substance (EPS), cytochrome *c*, and riboflavin are not responsible to the asymmetrical redox phenomenon. The antagonistic relationship between the electrooxidation of $K_4[Fe(CN)_6]$ and the formation of Pd nanoparticles by MR-1 indicates that the nanoparticles blocked the pathways of MR-1 to react with $K_4[Fe(CN)_6]$. This study suggests the ability of MR-1 to selectively electrocatalyticly oxidize $[Fe(CN)_6]^{4-}$ and its versatile role in biogeochemical cycle.

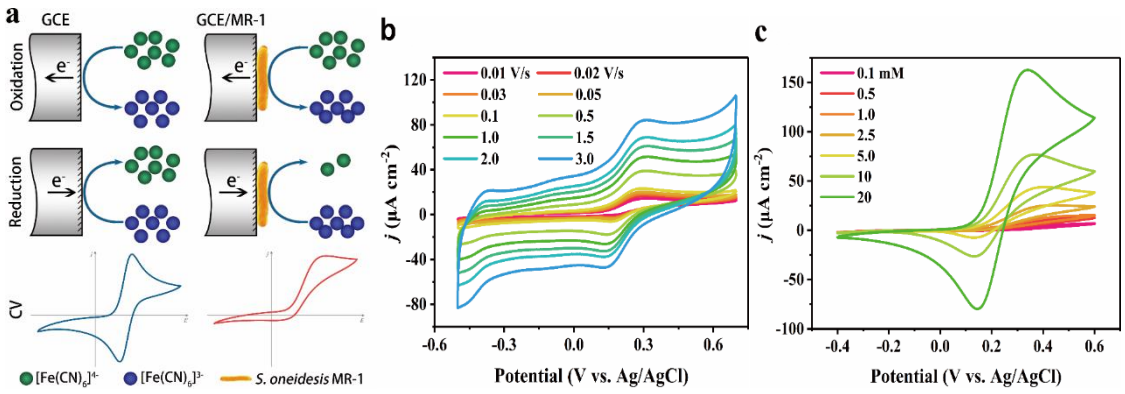

Fig. 1. (a) Reversible conversion of $[Fe(CN)_6]^{4-/3-}$ on GCE (left) and electrocatalytic oxidation of $[Fe(CN)_6]^{4-}$ to $[Fe(CN)_6]^{3-}$ by GCE/MR-1 (right). (b) Scan rate dependenct CVs and (c) concentration-dependent CVs of $[Fe(CN)_6]^{4-/3-}$ conversion. The scan rate is 10 mV/s unless otherwise stated.

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References

[1] C. R. Myers and K. H. Nealson, *Science*. **240**, 1319 (1988).
[2] Y. Xiao, E. Zhang, J. Zhang, Y. Dai, Z. Yang, H. E. M. Christensen, J. Ulstrup, and F. Zhao, *Sci. Adv*. **3**, e1700623 (2017).
[3] X. Tian, F. Zhao, L. You, X. Wu, Z. Zheng, R. Wu, Y. Jiang, and S. Sun, *Phys. Chem. Chem. Phys*. **19**, 1746 (2017).